REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 1999	FINAL REPORT (30 Apr 96 - 31 May 97)

4. TITLE AND SUBTITLE

Magellan II LFA15

5. FUNDING NUMBERS

N00014-96-1-0981

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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of Naval Research
800 N. Quincy St.
Arlington, VA 22217-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Acoustic data from a horizontal line array deployed from the R/V Cory Chouest were analyzed for marine mammal sounds in order to assess the accuracy of Navy personnel in detecting and identifying whale vocalizations, and to determine whether there was any evidence of potential impact on whales from SURTASS LFA transmissions. Results were based on an analysis of 386 hours from the LFA-15 exercise, February and March 1996. Detection and identification of blue whale signals was poor in both months, while good for fin whales. Errors had little or no impact on compliance because most of the whale calls that were missed were probably from distant animals. Whale acoustic detections were converted into probability of detection statistics with appropriate confidence intervals, and detection probabilities were compared between the LFA-on and LFA-off conditions. The data provide some evidence that whales are less likely to call when the SURTASS-LFA is transmitting. However, the data for this set of circumstances are too sparse to make an accurate assessment of impact. In order to accurately assess the effects of SURTASS-LFA transmissions on whale call probability, transmissions need to be turned off on a more regular basis for periods of 1 hour or longer.

14. SUBJECT TERMS

15. NUMBER OF PAGES
4

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

FINAL REPORT

Grant #: N00014-96-1-0981

PRINCIPAL INVESTIGATOR: Dr. Christopher W. Clark

INSTITUTION: Cornell University

GRANT TITLE: Magellan II/LFA 15

AWARD PERIOD: 30 Apr 96 - 31 May 97

OBJECTIVE: To analyze existing data from the passive acoustic horizontal line array and gathered by the crew on board the R/V Cory Chouest in order to:

- assess the accuracy of the Cory personnel at detecting and identifying low frequency (<200Hz) marine mammal vocalizations, primarily the calls of blue and fin whales. This assessment is designed to determine how well the mechanics of the mitigation and compliance procedures were working, and
- determine whether there is any evidence of potential impact on whales from LFA transmissions

APPROACH: The methods used to accomplish the primary objective were:

- For each of the available data sets from the different LFA tests, compute total whale calls per unit time for each species detected.
- Compute the vocal rates for the different species under different operating conditions.
- Statistically compare the acoustic results for the different operating conditions.
- Evaluate these results in terms of the potential biological impact.

ACCOMPLISHMENTS: Based on a the initial evaluation of the existing acoustic data sets from the R/V Cory Chouest, only one set contained sufficient numbers of whale calls to be useful for analysis. These were the data from the LFA-15 test conducted in the southern California Bight regions during February and March of 1996.

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Files from the LFA-15 exercise were converted into and archived as 11-minute, 4-channel files. For each file, the number of blue whale calls and fin whale calls (the call counts) was noted, as was the estimated number of whales calling of each species (whale counts). In most cases, the relative intensity of the highest-amplitude whale call in the file was also noted. Whale count data were recorded both on a file-by-file basis and for successive 15-minute intervals. A record was also kept of the presence or absence in each file and 15-minute interval of "volcanic blue" signals[1].

Performance evaluation: The Cory crew was evaluated for their ability to correctly detect and identify blue and fin whale calls. This was done by comparing the 15-minute whale counts logged by personnel on the Cory in real-time to counts for the same intervals as determined by Cornell technicians during post-processing. The time blocks that were selected for analysis contained a roughly equal mix of intervals when Cory personnel reported whales and intervals with no whales reported. The data were analyzed "blind" in that the Cornell technicians did not know while they were examining the spectrograms what data had been reported by personnel on the Cory for any given interval. In total there were 1248 15-minute intervals compared, 808 from February and 440 from March.

Blue whales. Detection of blue whale signals was poor in both months. In February, Cory personnel missed detecting blue whales in all 41 of the intervals in which Cornell technicians detected them. All of the 44 intervals with blue whale detections reported by Cory personnel turned out to have no blue whales in them according to Cornell technicians. In all likelihood, these were volcanic blue signals misidentified as blue whales by Cory personnel. For the March1996 at-sea period, Cory personnel detected no blue whales in any of the 440 intervals that were analyzed, while during post-processing Cornell staff detected blue whales in 15 of those 440 intervals.

Fin whales. Cory personnel detection of fin signals was considerably better than performance with blue whales in both months. Averaging across the two months, Cory personnel detected fins in 63% of the intervals when they were detected by Cornell technicians. 16% of the intervals

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[1]"Volcanic blue" is the name given to a low-frequency signal that has been frequently detected in the north Pacific since early 1991. Initially, observers who recorded this signal suspected that it came from blue whales. Data presently available suggest that the signal originates from a geological event somewhere in the southern hemisphere near 54°S

in which the Cory logged fin detections were scored as containing no fin whale calls by Cornell staff.
Significance of discrepancies. The apparent detection and identification errors probably had little or no impact on compliance with the mitigation protocol because most of the whale calls that were missed were fairly weak calls, hence probably from distant animals.

Effects of LFA on whale behavior: Results are based on the analysis of 386 hours from a total of 655 hours of available data for the LFA-15 exercise. Because interest focused on the effect of LFA transmissions on whale calling, files were selected that occurred during and near periods in which there were gaps in the transmission schedule of one hour or more. Whale acoustic detections/11-minute interval (a sample) were converted into probability of detection statistics with appropriate confidence intervals for each sample. Statistical analysis of detection probability as a function of condition (LFA-on vs. LFA-off) over the time course of the LFA test provided the basis for comparative analysis. This method was developed by a senior statistician with expertise in time series sampling theory and statistical applications. There were not enough control samples from LFA-off periods to test for the statistically significance of differences between the two conditions. However, there were enough data to yield insights into potential responses. When call detection probability is low, there is little difference in the probability of call detection between the LFA-on and LFA-off conditions. However, when the probability of a call is high, it is higher during LFA-off periods than LFA-on periods.

When the LFA-on and LFA-off error bands do not overlap, the call probabilities differ significantly. For example, in the March data there was a significant difference between call probabilities, with the probability of detecting a call when LFA transmissions are suspended being much higher than the probability when LFA transmissions occur.

CONCLUSIONS: Significance of discrepancies in whale vocal detections. The apparent detection and identification errors probably have had little or no impact thus far on compliance with the mitigation protocol because most of the whale calls that were missed were fairly weak calls, hence probably from distant animals.
Significance of LFA transmissions on whale vocal activity: If one considers only time periods when a control period

with high or medium-intensity calls is followed by the LFA-on condition, the data provide some evidence that whales are less likely to call when the Cory is transmitting. However, the data for this set of circumstances are too sparse to make an accurate assessment of impact. In order to accurately assess the effects of LFA transmissions on whale call probability, transmissions need to be turned off on a more regular basis for periods of 1 hour or longer. If this is not practical, transmission should be turned off and on for periods of an hour or longer during times when the call rate is relatively high. Transmissions will, of course, need to be off under certain conditions to remain in compliance with the mitigation protocols (e.g., during periods when whales are within 1 nautical mile of the vessel). Archiving of acoustic data should continue at all times, and the detection time and location of nearby animals along with clear records of transmission activity should be recorded and kept with the data log.

SIGNIFICANCE: These analyses have indicated that Cory personnel either misidentified or did not detect blue and fin whale acoustic signatures. We believe this situation can be remedied through better training and on-board reference material. These misidentifications or non-detections did not impact the mitigation protocols since the animals were most likely outside of the mitigation area. A statistical analysis procedure that takes into account the special nature of time-series acoustic detection data was developed. Results suggest that whales might decrease their vocal activity during periods with LFA transmissions. Further research will need to be done with adequate control and experimental sample sizes before this suggestion can be fully evaluated.

PATENT INFORMATION: No patents

AWARD INFORMATION: Position honored with endowed chair.

PUBLICATIONS AND ABSTRACTS:

Altman, N. (1998) Acoustical and Visual Monitoring of Whales and Their Activities. Abstract presented 9 Aug 1998, Dallas TX. Joint Statistical Meetings Proc.

Acoustic and Visual Monitoring of Whales and Their Activities

Abstract of paper presented at the Joint Statistical Meetings, Dallas, August 9-13,1998.

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Hydroacoustics have become increasingly important to supplement or replace visual observation of whales and other marine mammals. In this poster session I summarize approaches to a number of studies including: use of dual mode (acoustic and visual) surveys of whales to determine population size, tracking individual animals from acoustic detections, and determining the response of marine mammals to noisy human activities. Statistical methods employed include distance sampling, penalized nonlinear models and graphical methods based on nonparametric smoothing.